



A Manual on Postharvest Handling of Cabbage



Crops Division, Bangladesh Agricultural Research Council
Asian Food And Agriculture Cooperation Initiative

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Authors

S. M. Khorshed Alam, Ph.D
Mian Sayeed Hassan, Ph.D
Prof. Md. Kamrul Hassan, Ph.D
Md. Aziz Zilani Chowdhury, Ph.D
Abul Kalam Azad, Ph.D



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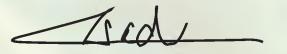
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Bangladesh Agricultural Research Council, Farmgate, Dhaka-1215, Bangladesh

Foreword

Cabbage is an excellent source of natural antioxidant, vitamins and minerals. Bangladesh produces substantial amounts of cabbage every year. However, considerable quantities of the harvested cabbages are lost every year, and the estimated postharvest loss is around 25%. Hence, improvement of postharvest handling is necessary to reduce loss and contribute to the improvement of nutrition security in the country. Postharvest research, training and extension are still inadequate in Bangladesh. Nonetheless, research works to minimize postharvest losses and maintain quality and safety of horticultural produce have been prioritized by the government of Bangladesh. Adequate emphases are to be paid on the improvement of handling practices including harvesting, packaging, transportation and storage of cabbages. Presently, there is paucity of user-friendly instruction manual on postharvest handling of horticultural crop including cabbage.

I am very glad to know that BARC is going to publish a manual on Postharvest Handling of Cabbage in Bangladesh with the financial support from the AFACI Postharvest Project (Establishment of Network and Model Manual on Postharvest of Horticultural Crops in Bangladesh). The manual elaborates the present status of postharvest practices in Bangladesh and how to improve the postharvest handling system so as to minimize loss and maintain quality and safety of cabbage in supply chain. My firm belief is that the manual would be of great help for different stakeholders in cabbage supply chains including growers, traders, scientists, researchers, extension workers, students and educationists, and will contribute to the expansion of cabbage to industries of the country.

I convey my sincere thanks to the authors and the scientists of Bangladesh Agricultural Research Council (BARC), BAU (Bangladesh Agricultural University), SAU (Sher-e-Bangla Agricultural University) and BARI (Bangladesh Agricultural Research Institute) who directly and indirectly contributed to bring out this piece of valuable document.



(Dr. Abul Kalam Azad)
Executive Chairman, BARC

Preface

Cabbage is a highly nutritious vegetable which is an excellent source of vitamins, minerals and antioxidant. In Bangladesh, cabbage is mainly grown in the winter season. Recently, some heat tolerant varieties have been developed which can be grown in summer. Cabbages are grown all over the country. However, commercial production is concentrated in Rangpur, Rajshahi, Bogra, Comilla, Chittagong, Norshingdi and Jessore. Area, production and yield of cabbage increased over the last several years. Presently 0.2 million metric tons of cabbages are produced from 16.7 thousand hectares of land. Unfortunately, a considerable quantity of cabbages is lost every year after harvest. The total estimated loss along the marketing channel is around 25%. Hence, improvement of postharvest handling is necessary to minimize loss and maintain quality and safety. Earlier research and training were mainly production-oriented. Postharvest research, training and extension were inadequate for long time. Nevertheless, postharvest research and training in terms of minimization of losses, maintenance of quality and safety in supply chain and value addition activities have been prioritized by the government of Bangladesh. The present initiative to publish "**A Manual on Postharvest Handling of Cabbage in Bangladesh**" as part of the AFACI Post Harvest Project is aimed at elaborating the present status of postharvest practices in Bangladesh and how to improve the postharvest handling system so as to minimize loss and maintain quality and safety of cabbage in supply chain.

This publication is possibly first of its kind in Bangladesh. It is not unlikely that there may have some ambiguities in the document. Any comments or suggestions on the contents would be highly appreciated for further improvement of the manual in future.

Authors

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Dr. Golam Morshed Abdul Halim

CSO, Vegetable Division, HRC, BARI

Dr. Madan Gopal Saha

CSO, Fruit Division, HRC, BARI

Dr. Md. Miar Uddin

CSO, Postharvest Technology Division, BARI

Dr. Md. Nazrul Islam

PSO, Postharvest Technology Section, HRC, BARI

Dr. Md. Nazim Uddin

SO, Vegetable Division, HRC, BARI

Dr. Md. Saleh Ahmed

Adviser, Hortex Foundation

Dr. Md. Sekendar Ali

Professor, Agric. Extension Dept., SAU

Dr. Md. Abdus Salam

PSO, Crops Division, BARC

Dr. Md. Atiqur Rahman

SSO, Postharvest Technology Section, HRC, BARI

M.S. Alam

Ex-Editor (Technical), BARI

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1. Cultivation System and Postharvest Procedure

- In Bangladesh, presently around 0.2 million metric tons of cabbage are produced from 16.7 thousand hectares of land. Cabbage ranks the 5th position in terms of total area and production in Bangladesh.
- The varieties presently cultivated in Bangladesh are mostly hybrids.
- Some recently introduced hybrids are Summer Warrior F₁, Summer Star F₁, Autumn Queen F₁, Super Tropic F₁, Summer Boy F₁, Green Ball 40 F₁, Supreme Queen F₁, Green 60 and Nova F₁.
- Open pollinated varieties like BARI Cabbage-1 (Provati), BARI Cabbage-2 (Agradut), K-K Cross, K-Y Cross, Tokyo Pound, Atlas 70, Ruby Ball, Drum Head, etc. are also cultivated.
- Red cabbage is also becoming popular in Bangladesh as a salad crop.



Green cabbage grown in Bangladesh



Red cabbage grown in Bangladesh

■ Cultivation System

- Cabbage is generally grown in open field.
- Cabbage is grown well at temperature ranged between 15 and 20° C.
- Loam to sandy loam soil is suitable for growing cabbage.
- Seeds are sown in seedbed in August, September or November for early, mid and late season cultivation, respectively.
- The seed rate is 350-400 g/ha.
- Seedlings of 30-35 days old are to be transplanted with the spacing 60 cm × 45 cm.
- Fertilizer doses and application method:
"Fertilizer Recommendation Guide 2012" of Bangladesh Agricultural Research Council is to be followed for fertilizer management practices. Besides, fertilizer doses as recommended by Vegetable Division, BARI may be followed as per the following table:

Name of manure/fertilizer and doses

Manure/ Fertilizer	Total amount	During final land proportion (ha)	10 days after planting/ha	25 days after planting/ha	At head formation/ha
Cowdung	5-10 tons	All	-	-	-
Urea	225 kg/ha	-	-	-	-
TSP	375 kg/ha	All	-	-	-
MoP	250 kg/ha	100 kg/ha	50 kg/ha	50 kg/ha	50 kg/ha

Above mentioned recommended doses of TSP, MoP and cowdung are to be mixed well and applied during final land preparation. In case of topdress of urea and MoP, these should be applied mixing well with soil 10-15 cm apart from plants.

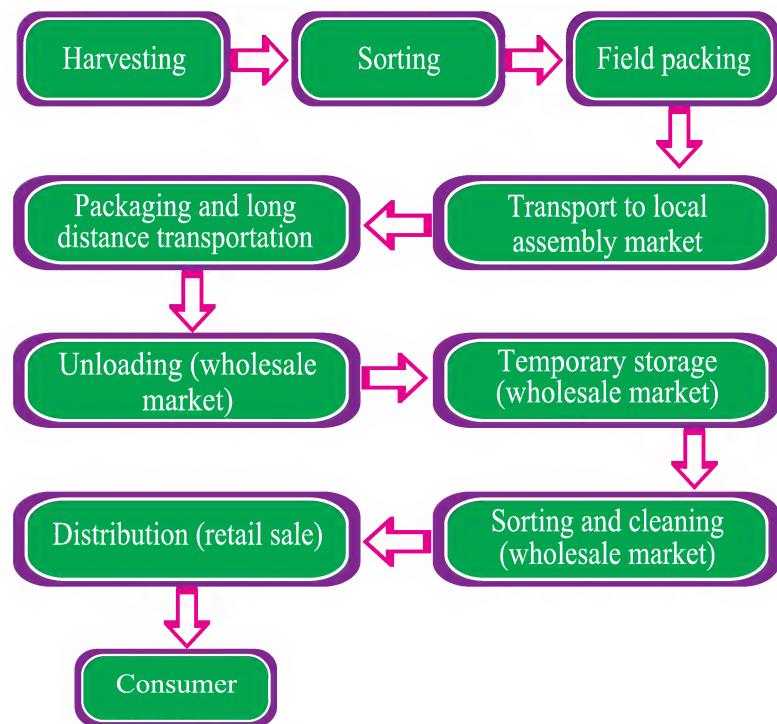
- Crop should be kept weed free for normal growth of plants. After planting, soil to be pulverized and irrigation to be applied.
- Cabbage looper and Diamondback moth larvae are the major insect pests.
- Leaf spots and black rot are the major diseases.
- Combination of IPM and chemical control is practiced to control pests and diseases.
- Cabbage heads become harvestable within 60-90 days after transplanting.
- The average yield is 75-100 tons/ha.



Cultivation of cabbage in open field

■ Postharvest handling procedures of cabbage in Bangladesh

- Cabbage reaches the hands of consumers through a number of intermediaries or middlemen.
- The main market actors are growers, small primary traders (Faria), large primary traders (Bepari), commission agents, wholesalers, retailers and consumers.
- The following postharvest handling steps are generally observed for cabbage in Bangladesh:



Postharvest handling steps for cabbage in Bangladesh

2. Postharvest handling of cabbage in the field

2.1. Harvesting time

■ Determination of harvesting time

- Heads (edible part of cabbage) are harvested when they attain reasonable size having appropriate varietal shapes.
- Matured heads are compact and not depressed by finger pressure while immature heads are loosely formed and depressed by finger pressure.
- Matured heads produce metallic sound on finger stroke while immature heads produce dull sound.
- Premature heads may be harvested for higher profits for early market.
- Immature or over mature heads are not suitable for marketing because they lack nutritional and postharvest quality.



Matured (left) and immature (right) cabbage heads

■ Time of day for harvesting

- Cabbage is harvested in a clear and sunny day.
- Morning is the optimum time of harvesting because of prevailing low temperature with high humidity and absence of scorching sunshine.

2.2. Harvesting

- Heads to be cut using a sharp knife or sickle leaving $\frac{1}{2}$ (half) inch of the stem. Excessively long and protruding stems may cause bruises to other heads during subsequent postharvest handling.
- Prior to harvesting, insect damaged and yellowish outer leaves should be removed.
- Harvested cabbages are not left on soil to avoid contamination by dirt, harmful microbes or heavy metals.
- Cutting tools and harvesting containers should be regularly sanitized using ordinary detergent or bleaching solution.

2.3. Field packing

- Harvested heads to be kept in clean container like plastic crates, plastic buckets or plastic net bags.
- It is suggested not to use bamboo baskets to avoid bruising by the sharp edges of the baskets which causes rapid quality deterioration.
- Considering the existing reality, bamboo baskets can be used with proper lining materials like newspaper or soft clothes to reduce damage during transportation.

2.4. Transport from farm to packing shed/market

- For local transportation, cabbage heads are to be packed in plastic crates or plastic net bags or bamboo baskets and quickly transferred to the packing shed or nearby assembly market.
- Paper or cloth liners should be used, especially for bamboo baskets to minimize damage.
- Cabbages are to be covered with net or clothes during local transportation to prevent heat damage or avoid sunlight.



Cabbage in tukri



Cabbage in net



Cabbage in cloth bag



Cabbage in bamboo crate

Presently practiced modes of local transportation of cabbage

3. Postharvest handling in packing house and during marketing

3.1. Pre-cooling

- Pre-cooling is an important postharvest practice which helps maintain quality and extends shelf life of cabbage.
- Heads to be brought to the packing shed at low temperature to remove field heat.
- Forced air cooling is the best option to remove field heat from the solid heads.
- Growers are strongly suggested to hold harvested cabbage under shade and cool place of their house prior to or during packaging and transportation to the local assembly markets.

3.2. Sorting

- During sorting insect infested, diseased, rotten, damaged and bruised heads should be removed.
- Sorting should be practiced in cool place of the packing shed.
- In case of absence of structured packing shed, growers are suggested to perform sorting operation in cool and shady place of their house or in the field to maintain postharvest quality.

3.3. Grading

- Growers are suggested to grade cabbage into large, medium and small sizes for the convenience of the buyers.
- Prior to grading, the older outer leaves should be removed leaving only 3-4 intact wrapper leaves.
- Insect damaged, diseased, yellowish and older outer leaves should be removed during grading.

3.4. Packaging

- For local transportation, heads are to be packed in jute bags, plastic net bags or bamboo baskets. Paper or cloth liners should be used for bamboo baskets to minimize damage.
- For long distance transportation, larger size plastic crates are suitable to reduce damage and to maintain quality. Paper or plastic liners could be used inside the crates to minimize injury and weight loss.
- The packaging materials should be intact and clean to prevent contamination by microorganisms, insects and heavy metals.



Presently practiced packaging of cabbage in plastic sack (left), and plastic crate for improved packaging (right)

3.5. Long distance transportation

- Care should be taken during cabbage loading for long distance transportation with packaging materials like paper or soft clothes to minimize damage due to compactness, vibration and internal heat generation.
- The best option of transportation of cabbage is the use of refrigerated vehicle.

■ Measures for transportation

- Transport vehicle should not be overloaded.
- Cabbage should not be mix-loaded with other high ethylene liberating fruits like bananas, tomatoes, papaya, etc., which results in leaf discoloration and reduced shelf life.
- Strong and durable packages should be used.
- Packages should be aligned properly.
- Vibration damage should be reduced by using plastic crates, liners and padding.



Open truck, predominantly used for bulk and long distance transportation (left) and refrigerated Reefer Truck of Hortex Foundation (right)

- Ventilation should be ensured to prevent heat generation during transportation.
- Rough handlings during loading and unloading should be avoided and workers should not stand upon the produce.
- Crates should be loaded in uniform stacks and braced securely.
- The entire load should be covered with light-coloured and thick canvas.

3.6. Storage

- For storage, cabbage to be harvested at proper stage of maturity.
- Cabbage can be stored at 0° C and 98-100% RH for 4-16 weeks; at 4° C and 80-90% RH for 4-6 weeks; and at 20° C and 60-70% RH for one week. The best storage and transit temperature for cabbage is 0-4° C.
- Modified atmosphere (MA) using various types of plastic packaging (low density polyethylene bags, polypropylene bags, plastic film) to be used to wrap whole or cut cabbage to prolong their shelf life.
- MA storage in combination with low temperature may be suggested for more effective (Longer) shelf life.



Presently practiced temporary storage of cabbage in open sun without any cooling facilities

■ Measures for storage

- Cabbages for storage are to be harvested at proper maturity stage.
- Recommended temperature and relative humidity should be maintained.
- The storage room should not be overloaded.
- Adequate ventilation in storage rooms should be ensured.
- The storage room should always be kept clean.
- Ethylene sensitive commodities like apples, banana, tomatoes, papaya, etc. should not be held with cabbage.
- Produce should be regularly inspected to sort out damaged produce.



Presently practiced temporary storage of cabbage in shady place

3.7. Quality deterioration of cabbage

- Cabbage is highly perishable vegetable crop.
- Quality of cabbage deteriorates quickly due to water loss, desiccation, wilting, microbial infection, etc. if proper postharvest practices are not followed.
- Postharvest loss occurs at various stages of postharvest operations (Table 1).
- The principal causes of postharvest loss and quality deterioration are inadequate infrastructures for postharvest handling, increased postharvest physiological processes (respiration, ethylene production and transpiration), sub-standard post-harvest handling and microbial decay.



Good (A & B) and poor (C) quality cabbage

Table 1. Postharvest losses of cabbage in traditional supply chain in Bangladesh

Supply chain actors	Postharvest loss (%)	Major causes of loss
Growers	6.14	<ul style="list-style-type: none"> ⇒ Insect damage ⇒ Microbial decay ⇒ Lack of proper handling ⇒ Improper harvesting
Collectors (Bepari)	5.04	<ul style="list-style-type: none"> ⇒ Lack of sorting ⇒ Bulk transportation without proper packaging ⇒ Mixed load ⇒ Lack of proper handling
Wholesalers	4.46	<ul style="list-style-type: none"> ⇒ Improper handling ⇒ Lack of sorting and grading ⇒ Lack of storage facilities
Retailers	5.16	<ul style="list-style-type: none"> ⇒ Lack of storage facilities ⇒ No or delayed sale ⇒ Unhygienic market conditions
Consumers	4.14	<ul style="list-style-type: none"> ⇒ Lack of refrigerator in most households ⇒ Lack of proper packaging ⇒ Ignorance about packaging and storage
Total loss	24.94	

3.8. Effectiveness of improved postharvest handling

■ Comparison of postharvest handling

Table 2. Comparison of different technologies for post-harvest handling

Postharvest procedure	Conventional technology	Improved/standard technology
Harvesting maturity for storage	Head compact and firm	Head compact and firm
Field packing container	Bamboo baskets, plastic sacks, jute sacks	Plastic crates, net bags
Weight of container in the field	Bamboo basket (20-40 kg) plastic sack (20-40 kg)	Plastic crates (40-60 kg)
Cooling	Ambient condition (in cool and shady place)	Mechanical pre-cooling (forced air cooling)
Sorting	Quality	Size, colour, quality
Grading	Size	Size, colour, quality
Packaging materials	Bamboo baskets, plastic sacks, jute sacks	Plastic crates, cardboard boxes (rigid)
Weight of packaging	Plastic sack (40-60 kg)	Plastic crates (40-60 kg)
Storage temperature and humidity	Ambient	0-4°C temperature and 98-100% RH
Transportation	In open mini or large trucks at ambient condition	Controlled temperature in refrigerated vehicles
Postharvest losses	The estimated post-harvest loss is 25%	No report is available but postharvest loss would be greatly minimized under improved technology

4. New postharvest technology to extend storage life of cabbage

- Cabbage is a perishable leafy vegetable and is spoiled due to various reasons like microbial infections and water loss.
- Bacterial soft rot during storage and marketing is the most serious problem.
- Shelf life of cabbage can be prolonged by applying lime paste (lime in water at a ratio of 1:1) or alum paste (15g potassium aluminum sulphate in 100 ml water) to the stem butt end immediately after harvesting and sealing in PP bags with 0.5% perforations.
- Shelf life of the treated cabbage was significantly extended (14-15 days) over untreated control (6-7 days).